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A HYDROGENATED VINYL AROMATIC HYDROCARBON POLYMER COMPOSITION AND
AN OPTICAL DISK SUBSTRATE

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*[There are no amendments to this
patent.]*

(54) [Title of the invention]

A hydrogenated vinyl aromatic hydrocarbon polymer
composition and an optical disk substrate

(57) [Claim of the invention]

[Claim 1] A hydrogenated vinyl aromatic hydrocarbon polymer composition having a structure comprising two or three components selected from among

- (a) 1~100 wt% or less of a polymer produced by hydrogenation of all the double bonds and an aromatic nuclei included in vinyl aromatic hydrocarbon-conjugated diene block copolymer,
- (b) 0~95 wt% of a polymer produced by hydrogenation of at least 80 mole% of the aromatic nuclei included in the vinyl aromatic hydrocarbon, and/or
- (c) 0~20 wt% of a saturated hydrocarbon resin with a number average molecular weight of 500~5,000 and a softening point of 40°C or higher (in this case, the sum of component (b) and component (c) exceeds 0 wt%).

[Claim 2] The hydrogenated vinyl aromatic hydrocarbon polymer composition described in Claim 1 of the invention wherein the composition is used as an optical material.

[Claim 3] An optical disk substrate made of the hydrogenated vinyl aromatic hydrocarbon polymer composition described in Claim 1 of the invention.

[Detailed description of the invention]

[Field of industrial application]

The present invention pertains to a hydrogenated vinyl aromatic hydrocarbon polymer composition having excellent transparency, heat-resistance, and adhesion, and the invention further pertains to an optical disk substrate made of the above-mentioned hydrogenated vinyl aromatic hydrocarbon polymer composition.

[Prior art]

High-density data recording, storage, and playback are made possible in optical recordings made with a laser and active development of materials has been underway in recent years. As an example of the above-mentioned optical recording, optical disks can be mentioned. In general, optical disks basically consist of a transparent substrate and a variety of recording media coated onto the surface of the substrate.

[p. 2]

In many cases, a colorless transparent synthetic resin is used for the transparent substrate of the optical disk, and as typical examples, polycarbonate (hereinafter referred to as "PC") and polymethylmethacrylate (hereinafter referred to as "PMMA") can be mentioned. The above-mentioned colorless resins have excellent transparency and each has unique properties, but not all factors required for optical disks are not included, and many problems remain unsolved. For example, in the case of PC, a problem of birefringence based on the aromatic ring exists, and

moisture absorption and moisture permeability pose problems as well. On the other hand, problems based on inadequate heat-resistance, moisture absorption, and rigidity have been pointed out for PMMA.

As described above, each of the above-mentioned resins are used despite the unique problems mentioned above, but additional problems described below exist in reality for recording media coated onto transparent substrates made of these resins.

Meanwhile, a variety of research has been conducted for a long time on recording media used for optical disk. For example, for the so-called write-once type used exclusively for recording and playback, a pit type media is used, for the so-called recording-playback-erase-recording type, a phase transition type medium wherein crystal transition is used, magneto-optic type media wherein the magneto-optic effect is utilized, etc. are known. In the above-mentioned materials used for recording media, inorganic materials, for example, tellurium or oxides thereof, alloy compounds, etc. are used for write-once type, and amorphous alloy compounds of rare earth metal-transition metal compounds such as GdFe, TbFe, GdFeCo, and TbFeCo is mainly used for erasable type, and in general, film formation is performed onto the transparent substrate by means of dry treatment method such as sputtering under high vacuum.

Furthermore, problems described below further exist based on an inadequate heat-resistance of the resin used for the substrate. In other words, the temperature of the recording

medium at the time of writing and erasing of the information becomes as high as 200°C in optical disks, especially, write-once type. It is expected for the temperature of the substrate becomes very high at the time of writing and erasing of the information even when the heat is not directly applied to the disk substrate, and in a resin with an inadequate heat-resistance, problems such as deformation of the substrate or deformation of the disk itself take place.

Meanwhile, a heat treatment process is included in production process of the optical disk in order to prevent change in the substrate or recording medium with passage of time in many cases, and from the standpoint of productivity, reduction in the treatment time is desired by performing the treatment at as high a temperature as possible. In this case, a high temperature treatment is made impossible when the heat-resistance of the resin is inadequate, and productivity cannot be increased.

Thus, it is not possible to use PMMA with a low heat-resistance in order to withstand the high temperature used during the course of production of the optical disk and application of the disk, and study is focussed on PC having a higher heat-resistance in the past. However, the heat-resistance of the PC is not necessarily adequate, and a resin material having a higher heat-resistance is highly demanded.

As a means to compensate problems in resins such as PC and PMMA conventional used, a method where a transparent resin with a high softening point mainly comprising carbon and hydrogen can be

mentioned, and use of hydrogenated vinyl aromatic hydrocarbon polymer is being suggested by the present inventors in Japan Patent Application No. 63-149845.

[Problems to be solved by the invention]

However, the above-mentioned hydrogenated vinyl aromatic hydrocarbon polymer has a low adhesion typical of polyolefins, and adhesion with the recording film is not adequate and adequate life as a optical disk cannot be achieved.

[Means to solve the problem]

Based on the above background, and as a result of much research conducted by the present inventors into improvements in the resin to achieve strong adhesion with the above-mentioned recording layer, it was found that an optical disk substrate having excellent adhesion with the recording layer while maintaining the high heat-resistance of the initial hydrogenated vinyl aromatic hydrocarbon polymer can be achieved when a hydrogenated vinyl aromatic hydrocarbon polymer composition made of a vinyl aromatic hydrocarbon-conjugated diene block copolymer hydrogenated material having a specific hydrogenation ratio, or a mixture of a hydrogenated vinyl aromatic hydrocarbon polymer and a vinyl aromatic hydrocarbon-conjugated diene block copolymer hydrogenated material having a specific hydrogenation ratio, or a saturated hydrocarbon resin having a number average molecular weight of 5000 or below and having a softening point of 40°C or higher is added to the above-mentioned materials, and the present invention was accomplished.

In other words, the present invention is a hydrogenated vinyl aromatic hydrocarbon polymer composition comprising two or three components selected from among

(a) 1~100 wt% or less of a polymer produced by hydrogenation of all the double bonds and an aromatic nuclei included in vinyl aromatic hydrocarbon-conjugated diene block copolymer,

(b) 0~95 wt% of a polymer produced by hydrogenation of at least 80 mole% of the aromatic nuclei included in the vinyl aromatic hydrocarbon, and/or

(c) 0~20 wt% of a saturated hydrocarbon resin with a number average molecular weight of 500~5,000 and a softening point of 40°C or higher (in this case, the sum of component (b) and component (c) exceeds 0 wt%),

and the above-mentioned composition exhibits excellent adhesion with metals, metal oxides, and polymer compounds having polar groups, and can be used as an optical disk substrate having high adhesion with the recording layer.

[p. 3]

Component (a) of the composition of the present invention is a vinyl aromatic hydrocarbon-conjugated diene block copolymer.

For the vinyl aromatic hydrocarbon monomer included in the vinyl aromatic hydrocarbon segment of the raw material vinyl aromatic hydrocarbon-conjugated diene block copolymer, styrene, p-methylstyrene, α -methylstyrene, etc. can be mentioned, and as a typical example, styrene can be mentioned.

For the vinyl aromatic hydrocarbon copolymer segment, homopolymers made of one of the above-mentioned vinyl aromatic hydrocarbons or copolymers made of two or more of these can be mentioned. Furthermore, other monomers that are copolymerizable

with the above-mentioned vinyl aromatic hydrocarbons can be included in an amount that does not cause an adverse effect on the vinyl aromatic hydrocarbon polymer. For the above-mentioned monomers, acrylic acid, acrylate, methacrylic acid, methacrylate, maleic acid, maleic anhydride, acrolein, vinyl esters, vinyl ethers, vinyl ketones, acrylonitrile, etc. can be mentioned.

Furthermore, for the conjugated dienes included in the conjugated diene segment, 1,3-butadiene, isoprene, 2,3-dimethyl-1,3-butadiene, 1,3-pentadiene, 1,3-hexadiene, etc. can be mentioned, and 1,3-butadiene and isoprene are widely used. The above-mentioned block copolymer structure comprising at least two different types of segments can be easily produced using a standard method where a living anionic polymerization reaction is carried out, for example, a method wherein an organic lithium compound is used as a polymerization initiator, and a polymerization reaction is carried out in a hydrocarbon solvent such as hexane and heptane.

In this case, the amount of the vinyl aromatic hydrocarbon polymer segment included in the above-mentioned block copolymer is at least 20 wt%, preferably, at least 40 wt%, and especially at least 60 wt%. Furthermore, the amount of the conjugated diene polymer segment is 20 wt% or below for the total composition.

When the amount of the conjugated diene segment included in the composition becomes too high, heat-resistance and rigidity of the composition become inadequate and it cannot be used for optical disk substrates.

The molecular weight of the above-mentioned vinyl aromatic hydrocarbon-conjugated diene block copolymer raw material is in the range of 30,000~400,000, preferably in the range of 50,000~400,000 in terms of the number average molecular weight.

The vinyl aromatic hydrocarbon-conjugated diene block copolymer of component (a) of the composition of the present invention can be produced upon performing a hydrogenation reaction for the above-mentioned block copolymer in the presence of a hydrogenation catalyst capable of achieving an aromatic optical disk substrate. For the hydrogenation catalyst used in this case, for example, metals such as nickel, cobalt, ruthenium, rhodium, platinum, and palladium, oxides, salts, complex thereof, and the above-mentioned metals deposited onto a carrier such as activated carbon, diatomaceous earth, and alumina, etc. can be mentioned. Among those listed above, catalysts produced by depositing Raney nickel, Raney cobalt, stabilized nickel, ruthenium, rhodium, or platinum onto carbon or alumina are especially desirable from the standpoint of reactivity.

It is desirable to perform the above-mentioned hydrogenation reaction under a pressure of 50~250 kg/cm², and temperature of 100~200°C using a saturated hydrocarbon type solvent such as cyclohexane, methyl cyclohexane, n-octane, decalin, tetralin, and naphtha, or an ether type solvent such as THF. As for the hydrogenation ratio, the hydrogenation ratio of the double bonds based on the conjugated diene segment is essentially 100%. The hydrogenation ratio of the aromatic nuclei is 98 mol% or less,

preferably, 95 mol% or less, and especially 90 mol% or less. The lower limit of the hydrogenation ratio for the aromatic nuclei is 75 mol%, and preferably, 80 mol%. When the aromatic nuclei ratio is above the above-mentioned value, adhesion with the recording film becomes poor, and when the value is too low, problems such as reduction in the heat-resistance, increase in the birefringence, and poor solubility with component (b), etc. can be mentioned.

The molecular weight of the vinyl aromatic hydrocarbon-conjugated diene block copolymer of component (a) produced as described above is in the range of 20,000~300,000, preferably, 50,000~200,000, in terms of the number average molecular weight.

When the molecular weight is too low, the rigidity becomes inadequate, and on the other hand, when too high, molding properties and optical uniformity become inadequate.

Component (b) of the composition of the present invention is a hydrogenated vinyl aromatic hydrocarbon polymer.

For the raw material vinyl aromatic hydrocarbon polymer, the same type of polymers used for the above-mentioned vinyl aromatic hydrocarbon polymer segment included in the raw material component (a) can be mentioned. As for the polymerization method used, it is not especially limited as long as it is possible to produce a non-crystalline polymer, and in general, radical polymerization method, anionic polymerization method, etc. are used. It is desirable for the molecular weight of the above-mentioned raw material vinyl aromatic hydrocarbon polymer to be

at least 50,000 in terms of the number average molecular weight.

When the molecular weight is too low, heat-resistance and rigidity of the resin produced after the hydrogenation adduct treatment becomes poor.

Meanwhile, the upper limit of the molecular weight is not especially limited and in general, 400,000 or below is suitable.

A nuclei hydrogenation treatment is performed for the above-mentioned vinyl aromatic hydrocarbon as in the case of the hydrogenation of the above-mentioned component (a).

The degree of nuclei hydrogenation based on the nuclei hydrogenation treatment is at least 80 mol%. When the degree of hydrogenation is low, the heat-resistance becomes inadequate, and the birefringence as an optical material becomes too high, which is not desirable. The degree of the nuclei hydrogenation of the above-mentioned component is at least 90 mol% and at least 95 mol% is preferable.

The molecular weight of the hydrogenated vinyl aromatic hydrocarbon polymer produced as described above is in the range of 50,000~30,000 [sic] in terms of the number average molecular weight, and 60,000~250,000 is preferable. When the number average molecular weight is below 50,000, the strength becomes inadequate, which is not desirable, and on the other hand, when the above-mentioned value exceeds 300,000, molding properties and optical uniformity become poor, which is not desirable.

Component (c) of the present invention is a saturated hydrocarbon resin with a number average molecular weight in the

range of 500~5000 and softening point of 40°C or above. It is especially desirable when the number average molecular weight is in the range of 500~2000, and softening point is in the range of 60~200°C.

Component (c) is a component contributes for an increase in the adhesion.

When the molecular weight of the component (c) is too high, the increase in adhesion is not adequate. On the other hand, when the molecular weight of the component (c) is too low, problems such as airborne dust at the time of molding and bleeding take place and it cannot be used in practice. Furthermore, when the softening point is too low, the heat-resistance of the composition is reduced. The degree of hydrogenation of the resin of component (c) is at least 95%, and at least 98% is preferable. For the above-mentioned saturated hydrocarbon resin, resins such as hydrogenated petroleum resins, hydrogenated dicyclopentadiene resins, and polyvinyl cyclohexanes with a low molecular weight can be mentioned. The amount of each component included in the composition is in the range of 1~100 wt% or below for component (a), and preferably in the range of 10~99 wt%; in the range of 0~95 wt%, and preferably in the range of 0~90 wt%, for component (b); in the range of 0~20 wt%, and preferably in the range of 0~10 wt%, for component (c) (in this case, the sum of component (b) and component (c) exceeds 0 wt%).

Means used for mixing of the above-mentioned components is not especially limited, and in general, a method wherein the

above-mentioned components are first dissolved in a solvent and subsequently poured into a poor solvent, or removal of the solvent is performed, or a method wherein hot-melt mixing is performed by an extruder, Brabender blast-graph [phonetic] banbury mixer, or other mixing devices, etc. can be used.

Furthermore, a method wherein solution mixing is first performed followed by hot-melt mixing is also desirable.

In general, a heat stabilizer is mixed with the resin produced as described above in the present invention and molding is performed.

For examples of the above mentioned heat stabilizers, hindered phenol type heat stabilizers, sulfur type heat stabilizers, phosphorus type heat stabilizers, etc. can be mentioned. From the standpoint of an increase in the heat degradation resistance, it is desirable when a hindered phenol type heat stabilizer and a phosphorus type heat stabilizer are used in combination.

For examples of the hindered phenol type heat stabilizers used in the present invention, tetrakis[methylene-3-(3,5-di-t-butyl-4-hydroxyphenyl) propionate methane, 3,9-bis[1,1-dimethyl-2-{β-(3-t-butyl-4-hydroxy-5-methylphenyl)propionyloxy}ethyl]-2,4,8,10-tetrakis-pyrro[5,5]undecane, 1,3,5-tris(3,5-di-t-butyl-4-hydroxy benzyl-s-triazine-2,4,6(1H,3H,5H)-trion, 1,3,5-trimethyl-2,4,6-tris(3,5-di-t-butyl-4-hydroxybenzyl)benzene, etc. can be mentioned.

Furthermore, for examples of phosphorus type heat

stabilizers, tetrakis(2,4-di-t-butylphenyl)-4,4'-biphenylene phosphonite, bis(2,6-di-t-butyl-4-methylphenyl)pentaerythritol-di-phosphite, etc. can be mentioned.

A suitable amount of the above-mentioned stabilizer to be included is in the range of 0.01~1 part by weight in each case.

As for the mixing method used for the above-mentioned stabilizers and the resin composition of the present invention is not especially limited, and in general, mixing is done for the resin and stabilizers using a device such as ribbon blender, tumbler mixer, Henshel mixer, hot-melt blending is further performed by banbury mixer, uniaxial extruder, biaxial extruder to produce a pellet. Subsequently, the pellet produced as described above is used and injection molding is carried out at a molding temperature in the range of 270°C~330°C, especially, in the range of 280~340°C to produce an optical disk substrate having excellent transparency, heat-resistance and very low degree of optical distortion with an absence of coloring.

In the production of an optical disk with the optical disk substrate made of the hydrogenated vinyl aromatic hydrocarbon polymer composition of the present invention, a film made of Sn_2TaO_x , etc. are formed on the surface of the substrate using a method such as sputtering or deposition process, and a recording layer such as TbFeCo is formed on the surface and a protective layer is further deposited on the surface.

The optical disk substrate made of the polymer composition

of the present invention has excellent adhesion with the recording layer, thus a sufficiently long life of the optical disk can be achieved.

Furthermore, in addition to the above-mentioned optical disk, the polymer composition of the present invention may be used for moldings such as optical lenses and optical cards based on the excellent heat-resistance and optical properties. The high adhesion of the polymer composition of the present invention can be effectively utilized in the above-mentioned cases as well.

[Application Examples]

In the following, the present invention is explained further in specific terms with application examples and comparative examples, but the present invention is not limited to these examples as long as within the range of the invention. In this case, measurement of properties used in the application examples, comparative examples, and reference examples was done according to the methods explained below.

(1) Number average molecular weight:

Measurement was done by gel permeation chromatography (GPC) in THF as the solvent as in the case of polystyrene and the number average molecular weight in terms of polystyrene was obtained.

(2) Nuclei hydrogenation ratio (%):

Dissolving was performed for aromatic nuclei included in the vinyl aromatic hydrocarbon type resin in tetrahydrofuran (THF) and measurement of UV absorption was performed.

(3) Softening point (°C):

Measurement of the softening point temperature was performed by a Thermo-mechanical analyzer produced by Dupont [sic] Corp. using a penetration mode probe under a load of 5 g at a rate of 5°C/min. The thickness of the sample piece was 3 mm.

Resin Manufacturing Example 1

Dissolving was performed for styrene homopolymer (product of Mitsubishi Monsant Kasei Co., HH-102, number average molecular weight of 100,000) in tetrahydrofuran, and 5% Pd/C was added as a catalyst and a hydrogenation reaction was performed at a temperature of 170°C, hydrogen pressure of 100 kg/cm² for 6 hours. As a result, a hydrogenated polystyrene with a number average molecular weight of 68,000 and nuclei hydrogenation ratio of 99.0% was produced.

Resin Manufacturing Example 2

A hydrogenation reaction was performed for a styrene-butadiene block copolymer (number average molecular weight of 100,000 and butadiene content of 20 wt%) produced by an anionic polymerization method as in the case of Resin Manufacturing Example 1 so as to produce a hydrogenated styrene-butadiene block copolymer with a number average molecular weight of 870,000 and hydrogenation ratio of 87.5%.

Resin Manufacturing Example 3

A hydrogenation reaction was performed for a styrene-butadiene block copolymer (number average molecular weight of

105,000 and butadiene content of 5 wt%) produced by an anionic polymerization method as in the case of Resin Manufacturing Example 1 so as to produce a hydrogenated styrene-butadiene block copolymer with a number average molecular weight of 890,000 and hydrogenation ratio of 93.5%.

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Resin Manufacturing Example 4

A hydrogenation reaction was performed for a styrene-butadiene block copolymer (number average molecular weight of 120,000 and butadiene content of 40 wt%) produced by an anionic polymerization method as in the case of the Resin Manufacturing Example 2 so as to produce a hydrogenated styrene-butadiene block copolymer with a number average molecular weight of 950,000 and hydrogenation ratio of 85.5%.

Resin Manufacturing Example 5

A hydrogenation reaction was performed for a styrene-methyl methacrylate block copolymer (styrene content of 85 wt%, and number average molecular weight of 184,000) produced by a radical polymerization method as in the case of the Resin Manufacturing Example 1. As a result, a hydrogenated polymer with a hydrogenation ratio of 100% and a number average molecular weight of 144,000 was produced. Hydrogenation of the ester group did not take place.

Resin Manufacturing Example 6

Dissolving was performed for styrene homopolymer (product of Mitsubishi Monsant Kasei Co., HH-102, number average molecular

weight of 130,000) in tetrahydrofuran and 5% Pd/C was added as a catalyst and a hydrogenation reaction was performed at a temperature of 170°C, hydrogen pressure of 60 kg/cm² for 6 hrs. As a result, a hydrogenated polystyrene with a number average molecular weight of 75,000 and nuclei hydrogenation ratio of 80.2% was produced.

Application Example 1

Dissolving was performed for 3.75 kg of polymer produced in Resin Manufacturing Example 1, 1.25 kg of polymer produced in Resin Manufacturing Example 2, and 250 g of hydrogenated petroleum resin (product of Arakawa Chemical Co., Arukon [transliteration] P-100) in tetrahydrofuran and coprecipitation was further performed in methanol. For the wet powder produced above, 0.05 parts by weight each of 1,3,5-trimethyl-2,4,6-tris-(3,5-di-t-butyl-4-hydroxy benzyl) benzene (product of Japan Ciba Geigy Co. "Irganox 1330") and pentaerythritol diphosphite (product of Adeka-Argus [transliteration] Co. "MARKPEP-36") was added as add;s, and drying was further performed. Hot-melt kneading was performed by an extruder at 260°C and pelletization was performed.

A stamper having a groove was attached to the mobile die side of an injection molding machine (product of Meiki Co. "M140A") and molding of the above-mentioned pellet was performed at a resin temperature of 300°C so as to produce a disk substrate having a thickness of 1.2 mm and a diameter of 130 mm.

The softening temperature of the resin used for the substrate was 163°C and the bent modulus was 28,000 kg/cm².

The substrate produced was set for the sputtering device and exhaust was performed to achieve 8 x 10⁻⁷ torr or below, and a reactive sputtering was performed for the Ta target with a mixed gas comprising Ar and O₂, so as to produce an interference layer made of Ta₂O₅ (thickness of 800 Å). Subsequently, two-dimensional sputtering was performed with a Tb target and FeCo target with Ar gas so as to produce a recording layer made of TbFeCo (thickness 300 Å). Furthermore, sputtering was performed with an Al target and a Ti chip in an Ar gas so as to produce a reflective film. 10 lines were drawn in an area measuring 1 cm x 1 cm on the mirror surface of the above-mentioned film and an adhesive tape (imide film base) produced by Teraoka Co. was applied to the checker-board area design and the adhesion of the base with the tantalum oxide film was evaluated by peeling the above-mentioned film.

Not one square among 100 squares was removed as a result.

Application Example 2

150 g of polyvinyl cyclohexane with a low molecular weight (product of Arakawa Chemical Co., Arukon [phonetic] P-125, softening point of 125°C and molecular weight of 820) was added to 5 kg of the hydrogenated polymer produced in Resin Manufacturing Example 3 and pelletization, injection molding and sputtering were performed with the above-mentioned additives as in the case of Application Example 1. The softening temperature

of the substrate resin was 168°C and the modulus was 29,000 kg/cm². When the peel test was performed with a tape as in Application Example 1, not one square among 100 squares was removed as result.

Application Example 3

Pelletization, injection molding, and sputtering were performed for 2.5 kg of the hydrogenated polymer produced in Resin Manufacturing Example 1 and 2.5 kg of the hydrogenated polymer produced in Resin Manufacturing Example 2 as in the case of Application Example 2. The softening temperature of the substrate resin was 158°C and the modulus was 23,000 kg/cm². When the peel test was performed with a tape as in the application example above, not one square among 100 squares was removed as result.

Application Example 4

In Application Example 1, instead of the polymer produced in Resin Manufacturing Example 1, the polymer produced in Resin Manufacturing Example 5 was used and sputtering was further performed for the optical disk substrate produced above.

The softening temperature of the substrate resin was 161°C and the modulus was 28,000 kg/cm². When the peeling test was performed with a tape as in the case of the above-mentioned application example, not one square among 100 squares was removed as result.

Application Example 5

4.25 kg of the polymer produced in Resin Manufacturing Example 1, 0.75 kg of polymer produced in Resin Manufacturing Example 4 and 250 g of Arukon [phonetic] P-100 used in Application Example 1 were used and sputtering was further performed for the optical disk substrate produced above.

The softening temperature of the substrate resin was 160°C and the modulus was 27,000 kg/cm². When the peel test was performed with a tape as in the above-mentioned application example, not one square among 100 squares was removed as result.

Comparative Example 1

The additives described in Application Example 1 were added to 5.0 kg of the polymer produced in Resin Manufacturing Example 1 and pelletization, injection molding, and sputtering were performed in the same manner. The softening temperature of the substrate resin was 172°C and the modulus was 32,000 kg/cm². When the peeling test was performed with a tape as in the above-mentioned application example, all 100 squares among 100 squares were removed as result.

Comparative Example 2

In Application Example 1, instead of the hydrogenated polymer produced in Resin Manufacturing Example 2, a hydrogenated polymer with the hydrogenation ratio of 99.5% used in Resin Manufacturing Example 2 was used, and pelletization, injection molding, and sputtering were performed as in Application Example 1.

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The softening temperature of the substrate resin was 163°C and the modulus was 28,000 kg/cm². When the peel test was performed as described above, 98 squares among 100 squares were removed as a result.

Comparative Example 3

Additives described in Application Example 1 were added to 5.0 kg of the polymer produced in Resin Manufacturing Example 6, and pelletization, injection molding and sputtering were performed as described above. The softening temperature of the substrate resin was 150°C and the modulus was 32,000 kg/cm².

When the peel test was performed as described above, 5 squares among 100 squares were removed as result, and the heat-resistance was significantly reduced and adhesion remained poor.

The results obtained in the above-mentioned application examples and comparative examples are summarized in Table I below.

Table I

Application Example No.	Softening point (°C)	Modulus (kg/cm ²)	No. of squares removed among 100 (squares)
1	163	28,000	0
2	168	29,000	0
3	158	23,000	0
4	161	28,000	0
5	160	27,000	0
Comparison—1	172	32,000	100

Comparison—2	163	28,000	98
Comparison—3	150	32,000	5

[Effect of the invention]

The composition of the present invention has excellent heat-resistance, optical properties, and adhesion with the recording layer and the composition can be used effectively for optical disk substrates as well as other optical products.

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